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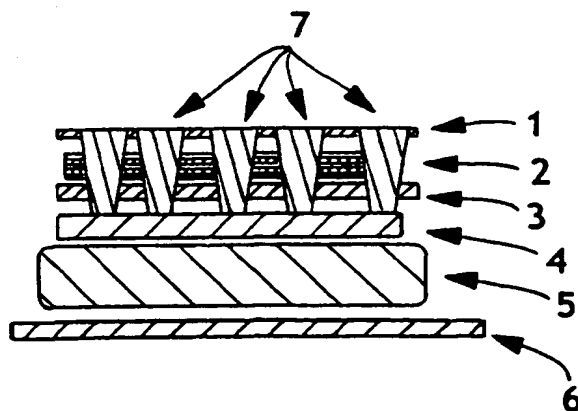
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(54) Title: CO-APERTURED SYSTEMS FOR HYGIENIC PRODUCTS



(57) Abstract: There is provided a system for a hygienic product having a cover layer, an intake/distribution layer and an absorbent core, in which at least the cover and intake/distribution layers are co-apertured. Combining these improvements into an integrated absorbent system allows the successful achievement of variable flow management and a successful balance between intake and cover desorption properties. The result is improved multiple intake performance and a clean and dry cover surface during use.

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## **CO-APERTURED SYSTEMS FOR HYGIENIC PRODUCTS**

### **FIELD OF THE INVENTION**

5           The present invention is a system for an absorbent, hygienic, personal care article, particularly feminine hygiene products. Such products must rapidly accept viscous fluid and retain it so that it does not spread outside the product where it may stain the wearer's garments.

### **BACKGROUND OF THE INVENTION**

10           Personal care articles include such items as diapers, training pants, feminine hygiene products such as sanitary napkins, panty-liners and tampons, incontinence garments and devices, bandages and the like. The most basic design of all such articles typically includes  
15 a bodyside liner (cover material), an outercover (also referred to as a baffle) and an absorbent core disposed between the bodyside liner and the outercover.

          Personal care products must accept fluids quickly and hold them to reduce the possibility of leakage outside the product. The product should be flexible and have a pleasing feel on the skin, and even after liquid insult, should not bunch, twist or bind the user  
20 making this uncomfortable for the wearer. Unfortunately, while previous products have met many of these criteria to varying degrees, a number have not.

          In particular, feminine hygiene products for longer-term (i.e. overnight) usage are subject to higher and more variable flow rates and fluid loads than are those intended for regular or shorter term usage. Products for overnight usage, therefore, must have the  
25 ability to absorb and contain continuous and light flow as well as gushes and sudden heavy flow over the life of the product. It has been found that continuous flow insults in

feminine hygiene products average 1 ml/hr, but may be higher, and are not literally continuous or constant, but rather variable in rate and may even pause during a cycle. "Gush flow" is defined as a sudden heavy flow condition and occurs at flow rates of up to 1ml/sec. During a gush, 1-5 ml of fluid is released from the body onto the product. The term "continuous flow" is used to define any flow which falls outside of the definition of gush flow.

Combining continuous and gush flow condition, results in variable flow. Essentially, "variable flow" is defined as continuous flow with intermittent gush flow occurrences. Figure 1 is a graph which illustrates the differences between variable flow (diamonds) and continuous flow (squares) over the life of a single product where flow rate is on the y-axis in g/hr and time is on the x-axis in hours. This problem of handling gush and continuous flows is termed variable flow management and is defined as the ability to absorb and contain continuous and light flow (1-2 ml/hr) as well as multiple gushes or sudden heavy flow insults (1 ml/sec with a total volume of 1-5 ml) over the life of the product.

The ultimate challenge for a product is to be capable of handling a gush (sudden flow) after the product has been insulted and the absorbent system is partially or completely saturated.

Many feminine care cover materials have low z-directional conductivity, low surface energy, low void volume, and provide little separation between the absorbent core and the user due to their two dimensional structure. Consequently, these covers result in slow and incomplete intake, high rewet, and large surface stains. In addition, typical intake or acquisition layers are low density, high void volume structures which are ideal for fast fluid intake, but because these structures typically have low capillarity and because of their generally fibrous nature, fluid is not adequately desorbed from the cover material, resulting in smearing and surface wetness. Materials which enhance cover desorption are

typically high density, high capillarity materials, but because these materials have low void volume and low z-directional permeability, they inherently retard fluid intake.

There remains a need for a system, which is designed to promote rapid intake and remain clean and dry, and which accepts fluids at the appropriate speed. There also  
5 remains a need for a system which further allows fluid to be absorbed in particular absorbent layers.

An objective of this invention is, therefore, to provide such a system. It is a further object of this invention to provide a design for a feminine hygiene product incorporating such a system, particularly for medium to high fluid loads.

10

### **SUMMARY OF THE INVENTION**

The objectives of the invention are achieved by a system having a cover layer, an intake/distribution layer and an absorbent core, in which at least the cover and  
15 intake/distribution layers are co-apertured. Other layers may be present as well, including surge and transfer delay layers. The cover may be a film or nonwoven fabric made from thermoplastic polymers. The intake/distribution layer is preferably a nonwoven fabric, and more preferably made by the airlaying process. Surge layers and transfer delay layers are generally nonwoven fabrics of varying wettability, pore size, permeability and fiber  
20 denier. The absorbent core may be made from pulp, superabsorbent or a variety of other absorbent materials. The system of this invention results in improved absorption of multiple insults allowing fluid storage in particular layers, providing a clean and dry cover surface during use. These functional properties are provided through improved material technologies and product construction.

25

### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a graph of variable flow (diamonds) and continuous flow (squares) over the life of a single product where flow rate volume is on the y-axis in g/hr and time is on the x-axis in hours.

Figure 2 shows a pin aperturing pattern at 7.4 apertures/cm<sup>2</sup> using 2.06 mm diameter pins.

Figure 3 shows a pin aperturing pattern at 2.5 apertures/cm<sup>2</sup> with the same pin diameter as Figure 2.

Figure 4 is a schematic diagram of a rate block apparatus suitable for use in determining fluid intake time of a material or material system.

Figure 5 is a schematic diagram of an absorbent system which has apertures throughout the cover and intake/distribution layer.

Figure 6 is a schematic of a similar coapertured absorbent system as Figure 5 but incorporates an additional material layer between the cover and the intake /distribution layer.

Figures 7, 8, 9, 10, 11, 12, and 13 are examples of zoned co-aperturing patterns that may be used in the practice of this invention.

### **DEFINITIONS**

As used herein the term "nonwoven fabric or web" means a matrix of individual fibers or threads which are interlaid, but not in an identifiable manner as in a knitted fabric. Nonwoven fabrics or webs have been formed from many processes such as for example, meltblowing processes, spunbonding processes, and bonded carded web processes. The basis weight of nonwoven fabrics is usually expressed in ounces of material per square yard

(osy) or grams per square meter (gsm) and the fiber diameters useful are usually expressed in microns. (Note that to convert from osy to gsm, multiply osy by 33.91).

"Spunbonded fibers" refers to small diameter fibers that are formed by extruding molten thermoplastic material as filaments from a plurality of fine capillaries of a spinneret.

5 Such a process is disclosed in, for example, US Patent 4,340,563 to Appel et al. The fibers may also have shapes such as those described, for example, in US Patents 5,277,976 to Hogle et al. which describes fibers with unconventional shapes.

"Bonded carded web" refers to webs that are made from staple fibers which are sent through a combing or carding unit, which separates or breaks apart and aligns the  
10 staple fibers in the machine direction to form a generally machine direction-oriented fibrous nonwoven web. This material may be bonded together by methods that include point bonding, through air bonding, etc.

"Airlaying" is a well-known process by which a fibrous nonwoven layer can be formed. In the airlaying process, bundles of small fibers having typical lengths ranging  
15 from about 3 to about 19 millimeters (mm) are separated and entrained in an air supply and then deposited onto a forming screen, usually with the assistance of a vacuum supply. The randomly deposited fibers then are bonded to one another using, for example, hot air or a spray adhesive. Airlaying is taught in, for example, US Patent 4,640,810 to Laursen et al.

20 As used herein, the term "coform" means a process in which at least one meltblown diehead is arranged near a chute through which other materials are added to the web while it is forming. Such other materials may be pulp, superabsorbent or other particles, natural polymers (for example, rayon or cotton fibers) and/or synthetic polymers (for example, polypropylene or polyester) fibers, for example, where the fibers may be of staple length.  
25 Coform processes are shown in commonly assigned US Patents 4,818,464 to Lau and



4,100,324 to Anderson et al. Webs produced by the coform process are generally referred to as coform materials.

"Co-aperture" refers to a material that has been apertured, as well as a process of aperturing, wherein two or more materials are apertured together. The apertures extend  
5 from top to bottom of the material and are essentially aligned with each other. Co-aperturing can join the materials either temporarily or permanently through entanglement, physical bonding or chemical bonding. Co-aperturing layers may be carried out at ambient or elevated temperatures. Higher temperatures aid the material bonding and create a cleaner pore. One process of co-aperturing is by forcing pins through the various  
10 layers by feeding them together through a nip formed by two counter-rotating rollers, one of which has pins to produce the apertures. The apertures may, for example, have a dimension of from 0.5 mm to 5 mm using a pin density of from 1 to 15 apertures/cm<sup>2</sup> and resulting in apertures having an area of less than 19.6 mm<sup>2</sup> and an open area ranging from about 2 to about 25 percent. Co-aperturing may be performed as a separate "off-  
15 line" operation or as part of a larger converting operation (in-line) depending on process economics and equipment availability. Examples of some co-aperturing patterns for feminine hygiene pads may be seen in Figures 7 –13.

"Transfer delay layer" refers to a material which slows down fluid transfer between other adjacent layers but which does not retain substantial amounts of fluid itself.

20 "Personal care product" means diapers, training pants, disposable swimwear, absorbent underpants, adult incontinence products, feminine hygiene products, wound care items like bandages, and other articles.

"Feminine hygiene products" means sanitary napkins or pads, and panty-liners.

"Target area" refers to the area of a personal care product where a wearer normally  
25 delivers an insult while the product is being worn.

## TEST METHODS

### Material caliper (thickness):

The caliper of a material is a measure of thickness and is measured at 0.05 psi (3.5  
5 g/cm<sup>2</sup>) with a STARRET®-type bulk tester, in units of millimeters. Samples are cut to 4" by  
4" (10.2 cm by 10.2 cm) squares and five samples are tested and the results averaged.

### Density:

The density of the materials is calculated by dividing the weight per unit area of a  
sample in grams per square meter (gsm) by the material caliper in millimeters (mm) at 0.05  
10 psi (3.5 g/cm<sup>2</sup>) and multiplying the result by 0.001 to convert the value to grams per cubic  
centimeter (g/cc). A total of three samples would be evaluated and averaged for the density  
values.

### Preparation of menses simulant:

The artificial menses fluid used in the testing was made according to US Patent  
15 5,883,231 from blood and egg white by separating the blood into plasma and red cells  
and separating the white into thick and thin portions, where "thick" means it has a  
viscosity after homogenization above about 20 centipoise at 150 sec<sup>-1</sup>, combining the thick  
egg white with the plasma and thoroughly mixing, and finally adding the red cells and  
again thoroughly mixing. A more detailed procedure follows:

20 Blood, in this Example defibrinated swine blood, is separated by centrifuging at  
3000 rpm for 30 minutes, though other methods or speeds and times may be used if  
effective. The plasma is separated and stored separately, the buffy coat removed and  
discarded and the packed red blood cells stored separately as well. It should be noted  
that the blood must be treated in some manner so that it may be processed without  
25 coagulating. Various methods are known to those skilled in the art, such as defibrinating  
the blood to remove the clotting fibrous materials, the addition of anti-coagulant chemicals

and others. The blood must be non-coagulating in order to be useful and any method that accomplishes this without damaging the plasma and red cells is acceptable.

Jumbo chicken eggs are separated, the yolk and chalazae discarded and the egg white retained. The egg white is separated into thick and thin portions by straining the white through a 1000-micron nylon mesh for about 3 minutes, and the thinner portion discarded. The thick portion of egg white, which is retained on the mesh, is collected and drawn into a 60 cc syringe, which is then placed on a programmable syringe pump and homogenized by expelling and refilling the contents five times. The amount of homogenization is controlled by the syringe pump rate of about 100 ml/min, and the tubing inside diameter of about 0.12 inches. After homogenizing the thick egg white has a viscosity of about 20 centipoise at  $150 \text{ sec}^{-1}$  and is then placed in the centrifuge and spun to remove debris and air bubbles at about 3000 rpm for about 10 minutes

After centrifuging, the thick, homogenized egg white, which contains ovomucin, is added to a 300 cc FENWAL® Transfer pack container using a syringe. Then 60 cc of the swine plasma is added to the FENWAL® Transfer pack container. The FENWAL® Transfer pack container is clamped, all air bubbles removed, and placed in a Stomacher lab blender where it is blended at normal (or medium) speed for about 2 minutes. The FENWAL® transfer pack container is then removed from the blender, 60 cc of swine red blood cells are added, and the contents mixed by hand kneading for about 2 minutes or until the contents appeared homogenous. A hematocrit of the final mixture should show a red blood cell content of about 30 weight percent and generally should be at least within a range of 28-32 weight percent for artificial menses made according to this Example. The amount of egg white is about 40 weight percent.

The ingredients and equipment used in the preparation of artificial menses are readily available. Below is a listing of sources for the items used, though of course other sources may be used providing they are approximately equivalent.

Blood (swine): Cocalico Biologicals, Inc., 449 Stevens Rd., Reamstown, PA 17567, (717) 336-1990.

FENWAL® Transfer pack container, 300 ml, with coupler, code 4R2014: Baxter HealthCare Corporation, Fenwal Division, Deerfield, IL 60015.

5 Harvard Apparatus Programmable Syringe Pump model no. 55-4143: Harvard Apparatus, South Natick, MA 01760.

Stomacher 400 laboratory blender models no. BA 7021, serial no. 31968: Seward Medical, London, England, UK.

10 1000 micron mesh, item no. CMN-1000-B: Small Parts, Inc., PO Box 4650, Miami Lakes, FL 33014-0650, 1-800-220-4242.

Hemata Stat-II device to measure hemocrits, serial no. 1194Z03127: Separation Technology, Inc., 1096 Rainer Drive, Altamont Springs, FL 32714.

#### Rate Block Intake Test

This test is used to determine the intake time of a known quantity of fluid into a  
15 material and/or material system. The test apparatus consists of a clear, preferably acrylic, rate block 10 as shown in Figure 4. The rate block 10 is 3 inches (76.2 mm) wide and 2.87 inches (72.9 mm) deep (into the page) and has an overall height of 1.125 inches (28.6 mm) which includes a center area 19 on the bottom of the rate block 10 that projects farther from the main body of the rate block 10 and has a height of 0.125 inches (3.2 mm)  
20 and a width of 0.886 inches (22.5 mm). The rate block 10 has a capillary 12 with an inside diameter of 0.186 inches (4.7 mm) that extends diagonally downward from one side 15 to the center line 16 at an angle of 21.8 degrees from the horizontal. The capillary 12 may be made by drilling the appropriately sized hole from the side 15 of the rate block 10 at the proper angle beginning at a point 0.726 inches (18.4 mm) above the bottom of the  
25 rate block 10; provided, however, that the starting point of the drill hole in the side 15 must be subsequently plugged so that test fluid will not escape there. The top hole 17 has a

diameter of 0.312 inches (7.9 mm), and a depth of 0.625 inches (15.9 mm) so that it intersects the capillary 12. The top hole 17 is perpendicular to the top of the rate block 10 and is centered 0.28 inches (7.1 mm) from the side 15. The top hole 17 is the aperture into which the funnel 11 is placed. The center hole 18 is for the purpose of viewing the progression of the test fluid and is actually of an oval shape into the plane of Figure 4. The center hole 18 is centered width-wise on the rate block 10 and has a bottom hole width of 0.315 inches (8 mm) and length of 1.50 inches (38.1 mm) from center to center of 0.315 inch (8 mm) diameter semi-circles making up the ends of the oval. The oval enlarges in size above 0.44 inches (11.2 mm) from the bottom of the rate block 10, for ease of viewing, to a width of 0.395 inches (10 mm) and a length of 1.930 inches (49 mm). Drilling may also make the top hole 17 and center hole 18.

A 10.2 cm by 10.2 cm (4" x 4") piece of absorbent 14 and cover 13 are die cut. The specific covers are described in the specific examples. The absorbent used for these studies was standard and consisted of 250 g/m<sup>2</sup> airlaid made of 90% CR-0054 (US Alliance Pulp Mills, Coosa, Alabama) and 10% KoSa T-255 binder unless otherwise specified. The total density for this system was 0.14 g/cc. The cover 13 was placed over the absorbent 14 and the rate block 10 was placed on top of the two materials. 2 mL of a menses simulant was delivered into the test apparatus funnel 11 and a timer started. The fluid moved from the funnel 11 into a channel 12 where it was delivered to the material or material system. The timer was stopped when all the fluid was absorbed into the material or material system as observed from the chamber in the test apparatus. The intake time for a known quantity of known fluid was recorded for a given material or material system. This value is a measure of a material or material systems absorbency. Typically, five to ten repetitions were performed, and average intake time was determined.

#### 25 Rewet Test

This test is used to determine the amount of fluid that will come back to the

surface when a load is applied. The amount of fluid that comes back through the surface is called the "rewet" value. The more fluid that comes to the surface, the larger the "rewet" value. Lower rewet values are associated with a drier material and, thus, a drier product. In considering rewet, three properties are important: (1) intake rate, since if the  
5 material/system does not have a good intake rate then fluid can rewet, (2) ability of absorbent to hold fluid (the more the absorbent holds onto the fluid, the less is available for rewet), and (3) flowback, the more the cover prohibits fluid from coming back through the cover, the lower the rewet.

Cover systems were evaluated in which the absorbent was maintained constant,  
10 removing the variable (2) from consideration. This left for consideration only variables (1) and (3), intake and flowback, respectively.

A 10.2 cm by 10.2 cm (4" x 4") piece of absorbent and cover was die cut. The absorbent used for these studies was standard and consisted of a 250 gsm airlaid made of 90% CR-0054 (US Alliance Pulp Mills, Coosa, Alabama) and 10% KoSa T-255 binder.  
15 The total density for this system was 0.14 g/cc unless otherwise specified. The cover was placed over the absorbent and the rate block was placed on top of the two materials. Two mL of menses simulant are delivered to the rate block apparatus and are allowed to absorb into a 4" x 4" sample of the cover material which is placed on top of a 4" x 4" absorbent piece. The fluid is allowed to interact with the system for one minute with rate  
20 block resting on top of the materials. The material system cover and absorbent are placed onto a bag filled with fluid. A piece of blotter paper is weighed and placed on top of the material system. The bag is traversed vertically until it comes into contact with an acrylic plate above it, thus pressing the whole material system against the plate blotter paper side first. The system is pressed against the acrylic plate until a total pressure of 1 psi is  
25 applied. The pressure is held fixed for three minutes, after which the pressure is removed and the blotter paper is weighed. The blotter paper retains any fluid that was transferred

to it from the cover/absorbent system. The difference in weight between the original blotter and the blotter after the experiment is known as the "rewet" value. Typically, five to ten repetitions of this test were performed, and average rewet was determined.

Triple Intake Test Procedure:

5           The objective of this test is to determine differences between materials and/ or materials, composites or systems of material composites in the intake rate when 3 sudden fluid insults (gushes) are applied, with time allowed for fluid to distribute in the material(s) between insults. The materials to be tested are prepared in the same manner as for the Rate Block Intake test described above. Two 2 mL of menses simulant is delivered to the  
10 materials via the rate block. The rate block is removed after 9 minutes and each layer is weighed and the weight recorded. This step is repeated for a total of 3 insults, after which a re-wet test as described above is performed and its value is recorded. The fluid loading in each component is calculated as weight after insult subtracted from the weight before insult. The insult time is a direct measurement of time for absorption. Smaller values of  
15 intake time refer to a more absorbent sample with larger values of intake time refer to a less absorbent sample. Three samples should be evaluated for each material

Fluid Distribution Test:

          This test is designed to measure the fluid distribution in the various layers that  
20 make up a personal care product, particularly a feminine hygiene product. Each layer of material in the sample to be tested should be weighed and the weight recorded before testing. The materials to be tested are placed flat and an hourglass shaped plate is placed on the material. The plate is preferably acrylic and is 21.5 cm in length, 8.7 cm in width, weighs 230 grams and has a 3 mm wide hole in its center. The plate is loaded with  
25 an additional 800 grams of weight distributed as uniformly as possible over its surface. Once the samples are ready for testing, 7 ml of menses simulant is delivered to the

sample through the hole at a uniform rate over a one hour period. One method of providing the simulant to the sample is with a Harvard Apparatus Model 55-4143 pump and plastic tubing, though comparable methods known to those skilled in the art may be used. After the hour, the plate is removed and the layers weighed. The difference in weight of the dry and wet layers is the amount of simulant absorbed in each layer. A percentage of fluid retained in each layer may then be calculated. Three samples should be evaluated for each material

### DETAILED DESCRIPTION OF THE INVENTION

10

In one, the invention is a composite for use in a feminine hygiene pad wherein the cover and intake/distribution layers of the composite are co-apertured. The layers are a cover, an intake/distribution layer, an optional surge layer, an optional transfer delay layer and an absorbent core. The fabrics used in the practice of this invention may be made by a variety of processes including airlaying, spunbonding, meltblowing, carding, coform and foaming processes, though airlaying for the intake/distribution layer and spunbonding for the transfer delay layer are preferred. The various layers may be made from synthetic polymer and natural fibers. Particularly preferred because of cost are polyolefins like polyethylene and polypropylene.

20

Figure 5 shows one embodiment of the invention. In Figure 5, the outercover 5 is the outermost part of the product. The absorbent core 4 is positioned near the outercover 5. Adjacent the absorbent core 4 is an optional transfer delay layer 3. The cover 1 and intake/distribution layer 2 are co-apertured as indicated by cones 6.

25

Figure 6 shows another embodiment of the invention, similar to Figure 5, wherein another layer(s) 7 has been interposed between the cover 1 and intake/distribution 2 layers. This additional layer 7 may be, for example, a surge layer.



It is important that a cover rapidly draw insults into the product and have a soft surface. A number of materials provide such intake properties. These include films, nonwovens and film/nonwoven laminates, nonwoven/nonwoven laminates, conjugate fiber spunbond fabrics, creped spunbond fabrics, airlaid fabrics, bonded carded webs, spunlace fabrics, embossed nonwoven fabrics, etc. A number of cover materials that may be unsuitable initially may be made acceptable through the use of topical chemical treatments and mechanical processing. Any material which, when combined with an absorbent core, permits rapid intake, low staining, low rewet and low fluid retention under all flow conditions would be suitable for use in the practice of this invention. These materials could also comprise different additives to improve softness or to deliver a skin wellness benefit.

The intake/distribution layer may be made from a variety of fibers and mixtures of fibers including synthetic fibers and natural fibers including mechanically and chemically softened pulp, staple fibers, slivers, meltblown and spunbond fibers, superabsorbents and the like. The fibers in such a web may be made from the same or varying diameter fibers and may be of different shapes such as pentalobal, trilobal, elliptical, round, etc. The intake/distribution layer may be made by a number of methods, including airlaying, hydroentangling, bonding and carding, and coforming, though airlaying is preferred. The intake/distribution layer may have a density between about 0.06 and 0.19 g/cc and a basis weight of between about 100 and 300 gsm.

The optional surge layer serves to absorb large sudden flows of liquid. Surge control materials, are provided to quickly accept the incoming insult and either absorb, hold, channel or otherwise manage the liquid so that it does not leak outside the article. Surge control is typically provided by a fluff pulp in an absorbent product or by a high permeability nonwoven layer, like spunbond fabric or bonded carded webs.

The optional transfer delay layer may also be made from a variety of fibers in a variety of shapes and sizes and may alternatively be a film. The transfer delay layer may be made according to a number of processes such as spunbonding, carding, meltblowing and film forming, though spunbonding is preferred. The purpose of the transfer delay layer is to slow the passing of fluid from the intake/distribution layer to the absorbent layer which are adjacent the transfer delay layer on either side.

The absorbent core or retention layer materials may be made from materials or substances known in the art to absorb liquid as well as any others that may be developed for that purpose. Examples include fast and slow superabsorbents, pulps, and mixtures thereof. Mixtures of superabsorbents and pulp used as retention materials may be used in ratios of between about 100/0 and 0/100 by weight, more particularly between about 80/20 and 20/80. The absorbent cores suitable for use in this invention typically have a density between about 0.05 and 0.20 g/cc and a basis weight between 150 and 500 gsm. There may be more than one layer comprising the absorbent core. Absorbent cores also usually have some type of binder to hold the components together. Typical binders include conjugate fibers, adhesive powders which may be heat activated, and liquid binders.

Synthetic fibers include those made from polyamides, polyesters, rayon, acrylics, superabsorbents, LYOCELL® regenerated cellulose and any other suitable synthetic fibers known to those skilled in the art. Synthetic fibers may also include kosmotropes for product degradation.

Many polyolefins are available for fiber production, for example polyethylenes such as Dow Chemical's ASPUN® 6811A linear low-density polyethylene, 2553 LLDPE and 25355 and 12350 high-density polyethylene are such suitable polymers. The polyethylenes have melt flow rates, respectively, of about 26, 40, 25 and 12. Fiber forming polypropylenes

include Exxon Chemical Company's ESCORENE® PD 3445 polypropylene and Montell Chemical Co.'s PF-304. Many other polyolefins are commercially available.

Natural fibers include wool, cotton, flax, hemp and wood pulp. Wood pulps include standard softwood fluffing grade such as CR-1654 (US Alliance Pulp Mills, Coosa, Alabama). Pulp may be modified in order to enhance the inherent characteristics of the fibers and their processability. Curl may be imparted to the fibers by methods including chemical treatment or mechanical twisting. Curl is typically imparted before crosslinking or stiffening. Pulps may be stiffened by the use of crosslinking agents such as formaldehyde or its derivatives, glutaraldehyde, epichlorohydrin, methyolated compounds such as urea or urea derivatives, dialdehydes such as maleic anhydride, non-methyolated urea derivatives, citric acid or other polycarboxylic acids. Some of these agents are less preferable than others due to environmental and health concerns. Pulp may also be stiffened by the use of heat or caustic treatments such as mercerization. Examples of these types of fibers include NHB416 which is a chemically crosslinked southern softwood pulp fibers which enhances wet modulus, available from the Weyerhaeuser Corporation of Tacoma, WA. Other useful pulps are debonded pulp (NF405) and non-debonded pulp (NB416) also from Weyerhaeuser. HPZ3 from Buckeye Technologies, Inc of Memphis, TN, has a chemical treatment that sets in a curl and twist, in addition to imparting added dry and wet stiffness and resilience to the fiber. Another suitable pulp is Buckeye HP2 pulp and still another is IP Supersoft from International Paper Corporation. Suitable rayon fibers are 1.5 denier Merge 18453 fibers from Acordis Cellulose Fibers Incorporated of Axis, Alabama.

Superabsorbents that are useful in the present inventions can be chosen from classes based on chemical structure as well as physical form. These include superabsorbents with low gel strength, high gel strength, surface cross-linked superabsorbents, uniformly cross-linked superabsorbents, or superabsorbents with varied

cross-link density throughout the structure. Superabsorbents may be based on chemistries that include but are not limited to acrylic acid, iso-butylene/maleic anhydride, polyethylene oxide, carboxy-methyl cellulose, poly vinyl pyrrolidone, and poly vinyl alcohol. The superabsorbents may range in rate from slow to fast. The superabsorbents  
5 may be in the form of foams, macroporous or microporous particles or fibers, may have fuzzy or fibrous coatings or morphology. The superabsorbents may be in the shape of ribbons, particles, fibers, sheets or films. Superabsorbents may be in various length and diameter sizes and distributions. The superabsorbents may be in various degrees of neutralization. Neutralization occurs through use of counter ions such as Li, Na, K, Ca.

10           Materials of this invention may include superabsorbents of the types mentioned above. An Example of these types of superabsorbents may be obtained from the Stockhausen Company (of Greensboro, NC) and is designated as FAVOR® 880. Examples of these types of superabsorbents obtained from Camelot Technologies Ltd. (of Alberta, Canada) are designated as FIBERDRI® 1241 and FIBERDRI® 1161. Examples  
15 of these types of superabsorbents obtained from Technical Absorbents, Ltd. (of Grimsby, UK) are designated as OASIS® 101 and OASIS® 111. Another Example included in these types of superabsorbents is obtained from Chemdall International (of Arlington Heights, Ill) and is designated FLOSROB® 60 LADY®. Still another Example included in these types of superabsorbents is obtained from Sumitomo Seika of Japan and is  
20 designated as SA60N Type 2.

Binders typically used in these structures help provide mechanical integrity and stabilization. Binders include fibers, liquids or other binder means which may thermally activated. Preferred fibers for inclusion are those having a relative melting point such as polyolefin fibers. Lower melting point polymers provide the ability to bond the fabric  
25 together at fiber crossover points upon the application of heat. In addition, fibers having a lower melting polymer, like conjugate and biconstituent fibers are suitable for practice of

this invention. Fibers having a lower melting polymer are generally referred to as "fusible fibers". By "lower melting polymers" what is meant are those having a glass transition temperature less than about 175 C. It should be noted that the texture of the absorbent web could be modified from soft to stiff through selection of the glass transition

5 temperature of the polymer. Exemplary binder fibers include conjugate fibers of polyolefins, polyamides and polyesters. Three suitable binder fibers are sheath core conjugate fibers available from KoSa Inc. (Charlotte, North Carolina) under the designation T-255 and T-256 or Copolyester designation, though many suitable binder fibers are known to those skilled in the art, and are available by many manufacturers such

10 as Chisso and Fibervisions LLC of Wilmington, DE. KoSa has developed a suitable copolyester binder fiber as a sheath core application and is known by designation T254 (low melt CoPET). A suitable liquid binder is KYMENE® 557LX available from Fibervisions LLC. Other suitable liquid binders include ethylene vinyl acetate emulsion polymers sold by National Starch and Chemical Company (Bridgeport, New Jersey) under the

15 tradename Dur-O-Set® ELITE® series (including ELITE® 33 and ELITE® 22). Air Products Polymers and Chemicals sells other suitable binder fibers under the name AIRFLEX®.

Once produced, the web must be adequately stabilized and consolidated in order to retain its shape. The inclusion of a sufficient amount of fusible fibers and subsequent

20 thermal bonding is the preferred method for obtaining adequate stabilization. It's believed that this method allows adequate bonding in the center of a thick material as well as on the surface.

As mentioned above, at least the cover and intake/distribution layers of this system are co-apertured, thus creating a structure that allows rapid intake of fluid and its

25 absorption on the designed absorbent layers. Other layers may optionally be co-apertured to each other or co-apertured with the cover and intake/distribution layers, or

not apertured at all. Co-aperturing the cover with the absorbent system improves the material permeability, thereby reducing fluid intake rate. Making pores through all the layers also creates the necessary passageways for the fluid in order for it to be absorbed in the preferred layers under high or gush flow conditions. This provides balance for fluid  
5 absorption in the X-Y and Z directions where the Y-direction is the direction from to back of a product, the Z-direction is perpendicular to the Y-direction and is into the product, and the X direction is perpendicular to both the Y and Z directions. Co-aperturing the layer simultaneously also provides a greater degree of structural integrity to the system.

The shape of the various layers is not considered critical to the success of the  
10 invention. It should be noted, however, that the airlaid intake/distribution and absorbent core or retention layers may also incorporate a reduced dimension rectangular strip geometry which prevents fluid from wicking to the pad edges when used, for example, in feminine hygiene products. The retention layer shape may be the same as or different from that of the other layers and any may have a rectangular, hourglass, racetrack or  
15 other shape. In addition, embossing may be added to the retention and/or other layers to enhance the integrity of the layer. Co-aperturing may be done in the center of the product only, to enhance the functionality of the product at the target area and to provide a visual cue to the user of the product's remaining life. Alternatively, the product could be co-apertured over its entire dimension or in other localized areas.

20 The cover may be treated with a surfactant to improve its wettability. This surfactant can be placed across the whole pad, in particular areas or zones or mixed internally into the fibers. For this last embodiment, if the material is pin apertured with hot pins, sufficient heat may be applied so that the surfactant "blooms" or moves toward the outer surface of the fiber, creating wettability regions surrounding the apertures and  
25 thereby improving the intake characteristics of the material. Examples of chemicals that could be used on this material could include but not limited to those marketed under the

tradenames AHCOVEL® (from ICI Surfactants, Wilmington, Delaware), GLUCOPON® (from the Henkel Corporation, Chemical's Group, Cincinnati, Ohio), PLURONICS® (from BASF of Germany), TRITON® X-102 (from the Union Carbide Corporation, Danbury, Connecticut), and MASIL SF-19® ( from PPG Industries, Inc., Gurnee, Illinois.) or a  
5 combination of them.

The optional fluid transfer delay layer in accordance with this invention is designed to enhance distribution in the x-y plane by delaying the transfer of fluid from the intake/distribution layer to the retention layer. A transfer delay layer allows fluid transfer to the retention layer when high pressures, high flow rates or saturation levels occur. This  
10 controlled transfer mechanism results in an elongated stain pattern in the retention layer, helps prevent over-saturation in the insult area and may provide a visual signal for the wearer indicating reduced product life remaining.

A transfer delay layer provides a permeability and wettability gradient between the intake/distribution layer and the underlying retention layer by preventing intimate contact  
15 between the two layers. A transfer delay layer should therefore have relatively low permeability and wettability so it will promote lateral fluid distribution within the intake/distribution layer under continuous flow conditions and so control fluid movement in the Z-direction. Under gush flow conditions, however, the apertures in the transfer delay layer allow fluid to immediately pass through to the underlying retention layer. The  
20 wettability of a transfer delay layer may be modified by topical chemical treatments as described above for the cover layer.

Another embodiment of this invention may include the co-aperturing of multiple layers that could make up the absorbent core, thereby allowing fluid to be moved and absorbed to the preferred product layers and improving fluid absorption. This increases  
25 the absorbent material utilization efficiency and creates a different absorption pattern.

The following examples were produced and tested in order to determine the amount of improvement provided by examples of systems according to the invention.

**Example 1:**

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc.

**Example 2:**

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.5 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.



Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc.

**Example 3:**

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive. The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm<sup>2</sup>. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc.

**Example 4:**

The layers described below were cut into 4" by 4" pieces and placed on top of each other in the order in which they are described, without the use of adhesive. The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm<sup>2</sup>. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with fibers of 3.5 dpf. Treated with 0.5 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent  
5 KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-  
10 255 binder fiber, 175 gsm and 0.10 g/cc.

Table 1

Example	Intake Time (Seconds)	Re-Wet (Grams)
1	103	0.11
2	75	0.13
3	50.5	0.12
4	33.5	0.23

As seen in Table 1 above, increasing the surfactant content on the nonwoven  
15 decreases the intake time of the absorption system. Furthermore, co-aperturing the layer reduces intake time even more. Having the combination of high surfactant levels and layers co-apertured enhances this effect.

**Example 5:**

These Absorbent prototypes were assembled with cover adhesive with an add-on level of 2-3 gsm forming a Kotex® Ultrathin Maxi product with Safety Zone® as currently sold in the US market.

5       Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied. The cover layer was 8 cm x 24.2 cm.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc. This layer was 10.2 cm by  
10   19 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer was 5 cm by 20.5 cm.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-  
15   255 binder fiber, 175 gsm and 0.10 g/cc. This layer was 6.4 cm wide by 21.5 cm long.

**Example 6:**

These Absorbent prototypes were assembled with cover adhesive with an add-on level of 2-3 gsm forming a Kotex® Ultrathin Maxi product with Safety Zone® as currently sold in the US market. The cover layer and intake/distribution layer only were co-  
20   apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm<sup>2</sup>. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond  
25   nonwoven fabric, 3.5 dpf. Treated with 0.5 volume percent AHCOVEL® surfactant topically applied. The cover layer was 8 cm x 24.2 cm.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc. This layer was 10.2 cm by 19 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445  
5 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer was 5 cm by 20.5 cm.

Absorbent layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm and 0.10 g/cc. This layer was 6.4 cm by 21.5 cm .

The product backing was a polyethylene film layer of 0.6 mils used as a fluid  
10 containment device. This layer is attached to the absorbent layer using 20 gsm of a hotmelt adhesive. The backing layer was 8 cm wide x 24.2 cm long.

#### Example 7:

These Absorbent prototypes were assembled with cover adhesive with an add-on level of 2-3 gsm forming a KOTEX® MAXI® product with SAFETY ZONE® as currently  
15 sold in the US market by the Kimberly-Clark Corporation.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied. The cover had a width of 8 cm in the target area and 9 cm on the lobes with a length of 22.0 cm.

20 Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc. This layer was 9.4 cm cm by 15.6 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL®  
25 surfactant. This layer was 4.8 cm wide with a length of 20.0 cm

Absorbent layer: Air formed NB416 pulp fluff, 430 gsm and 0.07 g/cc with a width of 6.0 cm in the target area, 7.0 cm on the product lobes and length of 20.0 cm.

Second absorbent : Air formed NB416 pulp fluff, 400 gsm with a density of 0.09 g/cc having a width of 4.5 cm and a length of 16.0 cm.

5 The product backing was a polyethylene film layer of 1.1 mils used as a fluid containment device. This layer is attached to the absorbent layer using 40 gsm of a hotmelt adhesive. The backing layer was 8 cm wide at the target area, 9 cm at the lobes with a length of 22 cm.

**Example 8:**

10 These Absorbent prototypes were assembled with cover adhesive with an add-on level of 2-3 gsm forming a KOTEX® MAXI® product with SAFETY ZONE® as currently sold in the US market by the Kimberly-Clark Corporation.

The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture  
15 open area of 14 percent having 8 holes /cm<sup>2</sup>. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.5 volume percent AHCOVEL® surfactant topically applied.

20 Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 250 gsm with a density of 0.14 g/cc. This layer was 9.4 cm cm by 15.6 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL®  
25 surfactant. This layer was 9.4 cm by 15.6 cm.

Absorbent layer: Air formed NB416 pulp fluff, 430 gsm and 0.07 g/cc with a width of 6.0 cm in the target area, 7.0 cm on the product lobes and length of 20.0 cm.

Second absorbent : Air formed NB416 pulp fluff, 400 gsm with a density of 0.09 g/cc having a width of 4.5 cm and a length of 16.0 cm.

5 The product backing was a polyethylene film layer of 1.1 mils used as a fluid containment device. This layer was attached to the absorbent layer using 40 gsm of a hotmelt adhesive. The backing layer was 8 cm wide at the target area, 9 cm at the lobes with a length of 22 cm.

10 The results of testing of the above described materials according to the intake and rewet tests shown above are in Table 2.

Table 2

Example	Intake Time (Seconds)	Re-wet (Grams)
5	67.17	0.13
6	33.52	0.16
7	113	0.09
8	41.11	0.09

15 As seen from these results, co-aperturing the materials showed a significant reduction in the absorption time of a single insult without affecting the re-wet values. It's the belief of the inventors that by providing a system that will provide a faster intake time, the run-off of the fluid from the cover is reduced, which also reduces the chance for the fluid to wick through the liner and the users body causing it to leak.

Co-aperturing of different product layers allows the product developer to control which layer should distribute or absorb fluid and to what degree. Table 3 provides Fluid Distribution Test data for Examples 5 – 8, showing the percentage of fluid retained in each layer. (Examples 6 and 8 were co-apertured).

5

**Table 3**

<b>Example</b>	<b>Fluid retained in Intake/distribution layer</b>	<b>Fluid retained in first absorbent layer</b>	<b>Fluid retained in secondary absorbent layer</b>
<b>5</b>	72.14	27.85	N/A
<b>6</b>	47.35	52.64	N/A
<b>7</b>	71.36	23.55	5.08
<b>8</b>	56.20	31.70	12.06

As can be seen from the data in Table 3, the co-apertured systems allowed better fluid distribution to the lower, absorbent layers, allowing the fluid to stay farther away from the cover and so producing a dryer surface for the wearer and more effectively using the total absorbent capacity of the product. The amount of fluid in the intake/distribution versus the combined absorbent layers may be expressed as a ratio, in this case a fluid partitioning ratio. The fluid partitioning ratio for materials according to this invention should be between 70/30 and 20/80, or more preferably between 60/40 and 20/80.

Clearly, the choice of raw materials and the choice of layers to be co-apertured determines how well a product will perform. One area in which this invention shows benefit is in a system having higher density absorbents closer to the cover. Such systems provide resiliency to the product to reduce bunching and twisting during use and tend to distribute fluid preferentially in the X-Y plane. This allows for the more effective absorption of multiple insults.

One skilled in the art may readily envision a product with different material densities and absorption properties that could benefit from co-aperturing of selected layers to allow faster absorption and fluid retention in preferred areas of the product. Aperturing configurations may be designed for different layers to improve fluid movement  
5 throughout the product.

Still other examples in which the cover was co-apertured with the intake layer can be seen in the following examples:

**Example 9:**

10 Cover layer: 20.3 gsm (0.6 osy) polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm with a density of 0.14 g/cc. This layer had a width of 19.0 cm and a length of 37 cm.

15 Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer had a length of 20.6 cm and a width of 4.8 cm

Absorbent layer: Air formed NB416 pulp fluff, 500 gsm, 0.09 g/cc, with a length of 20.6 cm and a width of 4.8 cm. A lower fluff with a basis weight of 600 gsm with 0.09 g/cc  
20 of density having a length of 29.5 cm, a width at the center of 6.5 cm and at the lobes of 7.5 cm

The product backing was a polyethylene film layer of 1.1 mils used as a fluid containment device. This layer was attached to the absorbent layer using 40 gsm of a hotmelt adhesive. The backing layer was 8.5 cm wide at the target area, 9.5 cm at the  
25 lobes with a length of 31.5 cm.



**Example 10:**

The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm<sup>2</sup>. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) polypropylene spunbond nonwoven fabric, 3.5 dpf.

Treated with 0.3 volume percent AHCOVEL® surfactant topically applied.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm with a density of 0.14 g/cc. This layer had a width of 19.0 cm and a length of 37 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer had a length of 20.6 cm and a width of 4.8 cm

Absorbent layer: Air formed NB416 pulp fluff, 500 gsm, 0.09 g/cc, with a length of 20.6 cm and a width of 4.8 cm and a lower fluff layer with a basis weight of 600 gsm with 0.09 g/cc of density having a length of 29.5 cm a width at the center of 6.5 cm and on the lobes of 7.5 cm .

The product backing was a polyethylene film layer of 1.1 mils used as a fluid containment device. This layer was attached to the absorbent layer using 40 gsm of a hotmelt adhesive. The backing layer was 8.5 cm wide at the target area, 9.5 cm at the lobes with a length of 31.5 cm.

**Example 11:**

The cover layer and intake/distribution layer only were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture open area of 14 percent having 8 holes /cm<sup>2</sup>. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 40 feet/minute.

Cover layer: 20.3 gsm (0.6 osy) ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric, 3.5 dpf. Treated with 0.3 volume percent AHCOVEL® surfactant topically applied.

5 Surge layer: 23.7 gsm (0.7 osy) 6 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric polypropylene fiber web with HR6 finish. Fibers with finish available from Chisso Corp. This layer had a width of 19.0 cm and a length of 37 cm with a thickness of 1.3 mm

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm with a density of 0.14 g/cc. This layer had a width of  
10 19.0 cm and a length of 37 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer had a length of 20.6 cm and a width of 4.8 cm

Absorbent layer: Air formed NB416 pulp fluff, 500 gsm, 0.09 g/cc, with a length of  
15 20.6 cm and a width of 4.8 cm, and a lower fluff layer with a basis weight of 600 gsm, 0.09 g/cc, having a length of 29.5 cm a width at the center of 6.5 cm and on the lobes of 7.5 cm .

The product backing was a polyethylene film layer of 1.1 mils used as a fluid containment device. This layer was attached to the absorbent layer using 40 gsm of a  
20 hotmelt adhesive. The backing layer was 8.5 cm wide at the target area, 9.5 cm at the lobes with a length of 31.5 cm.

#### Example 12:

The intake/distribution and transfer delay layers were co-apertured using a pin aperturing process using a pin roller and another (female) roller, resulting in an aperture  
25 open area of 14 percent having 8 holes /cm<sup>2</sup>. The temperatures used were 280° F (138° C) on the pin roll and 170° F (77° C) on the female roll at a speed of 50 feet/minute.

Cover layer: vacuum apertured polyethylene film with 17 percent open area, 100 holes/cm<sup>2</sup>, 19 gsm.

Intake/distribution layer: 90 weight percent NB416 pulp and 10 weight percent KoSa T-255 binder fiber, 175 gsm with a density of 0.14 g/cc. This layer had a width of 19.0 cm and a length of 37 cm.

Transfer delay layer: 27.1 gsm (0.8 osy), 2.8 dpf ESCORENE® PD-3445 polypropylene spunbond nonwoven fabric with 0.3 volume percent AHCOVEL® surfactant. This layer had a length of 20.6 cm and a width of 4.8 cm

Absorbent layer: Air formed NB416 pulp fluff, 500 gsm, 0.09 g/cc, with a length of 20.6 cm and a width of 4.8 cm, and a lower fluff layer with a basis weight of 600 gsm with 0.09 g/cc of density having a length of 29.5 cm, a width at the target area of 6.5 cm and on the lobes of 7.5 cm.

The product backing was a polyethylene film layer of 1.1 mils used as a fluid containment device. This layer was attached to the absorbent layer using 40 gsm of a hotmelt adhesive. The backing layer was 8.5 cm wide at the target area, 9.5 cm at the lobes with a length of 31.5 cm.

The Examples above were subjected to testing according to the triple intake and rewet tests described above and the results are shown in Table 4.

Table 4

Example	Intake Time 1 <sup>st</sup> Insult (Seconds)	Intake Time 2 <sup>nd</sup> Insult (Seconds)	Intake Time 3 <sup>rd</sup> Insult (Seconds)	Re-wet (Grams)
9	43	58	132	0.45
10	41	49	98	0.19
11	8	13	23	0.15
12	12	17	24	0.03

- 5 As seen from these examples; in the multiple insult situation co-aperturing of the cover with different absorbent layers has shown an advantage in reducing the material intake time. In Example 10, for example, further optimization of the open area available and the treatment could be made in order to further reduce the intake time of the system. What can be also seen in this data is that the materials having a larger void volume in the
- 10 cover generally have a faster intake time for multiple insults showing a significant reduction compared to the un-apertured absorption system.

As will be appreciated by those skilled in the art, changes and variations to the invention are considered to be within the ability of those skilled in the art. Such changes and variations are intended by the inventors to be within the scope of the invention.

What is claimed is:

- 1) A system for a hygienic product comprising a cover layer adjacent an intake/distribution layer which on the side opposite said cover layer is adjacent an absorbent core, wherein said cover and intake/distribution layers are co-apertured.
- 2) The system of claim 1 further comprising a transfer delay layer between said intake/distribution layer and said absorbent core.
- 3) The system of claim 1 having an open area from 2 to 25 percent and having apertures smaller than 19.6 mm<sup>2</sup> in area.
- 4) The system of claim 3 that has third insult intake time lower than 35 seconds.
- 5) The system of claim 3 that has a re-wet value of less than 0.3 grams.
- 6) The system of claim 1 wherein said intake /distribution layer has a basis weight between 50 and 500 gsm.
- 7) The system of claim 1 wherein said cover material is treated with a wettable surfactant.
- 8) The system of claim 1 wherein said cover material is treated with a skin wellness additive.
- 9) The system of claim 1 wherein said cover material is an embossed nonwoven fabric.

10) The system of claim 1 wherein said system has a fluid partitioning ratio of between 60/40 and 20/80.

5 11) A feminine hygiene pad comprising a nonwoven cover layer, intake/distribution layer and absorbent layer wherein said cover layer and said intake/distribution layer are co-apertured.

12) The pad of claim 11 further comprising a transfer delay layer adjacent said absorbent core.

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13) The pad of claim 12 wherein said transfer delay layer is a material selected from the group consisting of spunbond fabric, meltblown fabric, carded fabric and films.

14) The pad of claim 11 wherein said transfer delay layer is a spunbond fabric with a basis weight between about 15 and 50 gsm.

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15) The pad of claim 11 wherein said intake/distribution layer is a material selected from the group consisting of airlaid fabric, bonded carded webs, coform materials, hydroentangled pulp fabrics and meltblown fabrics.

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16) The pad of claim 11 wherein said intake/distribution layer is an airlaid fabric having a basis weight between about 100 and 300 gsm and a density between about 0.06 and 0.18 g/cc.

25 17) The pad of claim 11 wherein said cover, intake/distribution and transfer delay layers are co-apertured at a density of between about 1 and 15 apertures/cm<sup>2</sup>.

- 18) The pad of claim 11 further comprising a surge layer between said cover and intake/distribution layers.
- 19) The pad of claim 18 wherein said cover, surge and intake/distribution layers are co-apertured at a density of between about 1 and 15 apertures/cm<sup>2</sup>.
- 20) A feminine hygiene pad comprising a polypropylene fiber nonwoven fabric cover layer, a pulp and binder fiber intake/distribution layer having a density between about 0.09 and 0.19 g/cc and a basis weight of between about 100 and 300 gsm, a nonwoven fabric transfer delay layer, a first absorbent layer comprising pulp fluff having a density between about 0.05 and 0.10 g/cc and a basis weight between 150 and 500 gsm, and a secondary absorbent layer comprising pulp fluff and having a density less than said first absorbent layer, wherein said layers are co-apertured at a density of from 1- 15 apertures/cm<sup>2</sup>.

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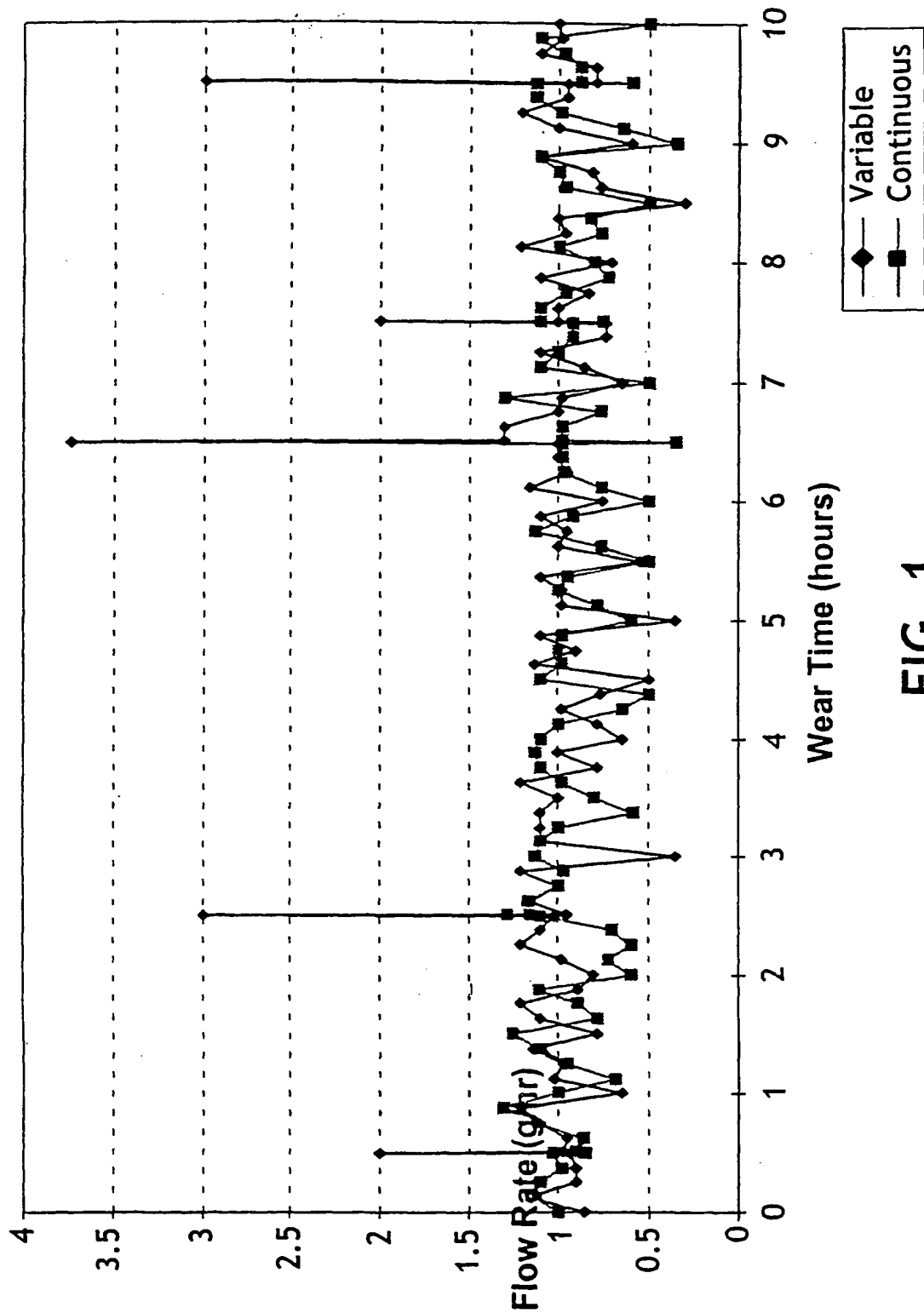


FIG. 1



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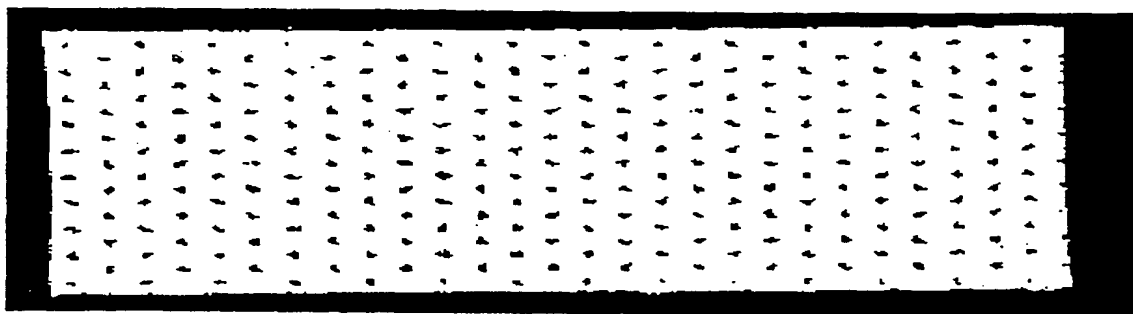


FIG. 2

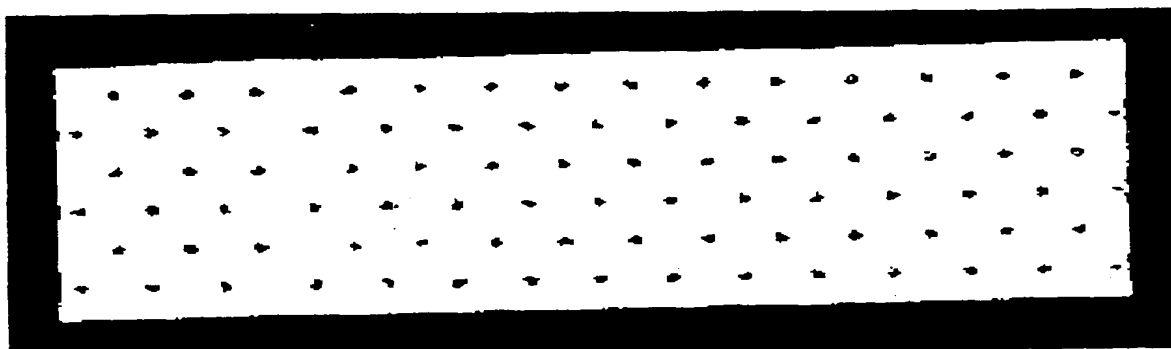
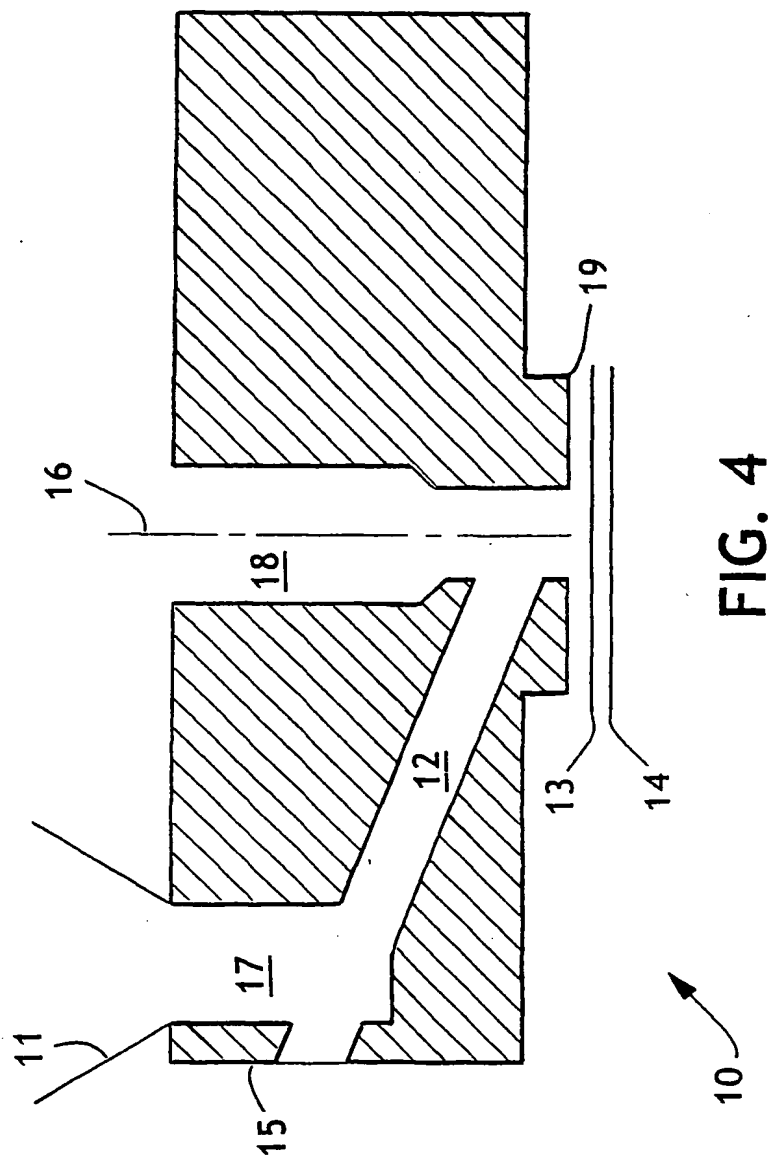


FIG. 3

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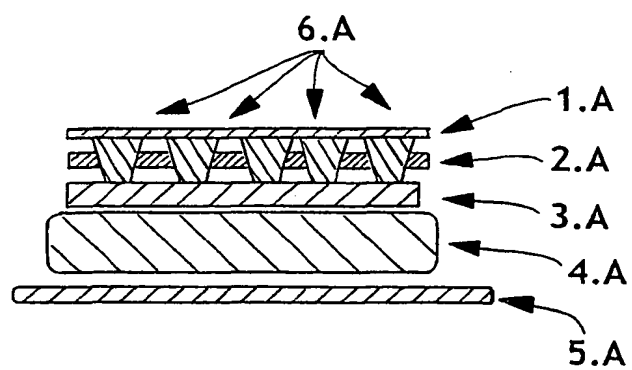


FIG. 5

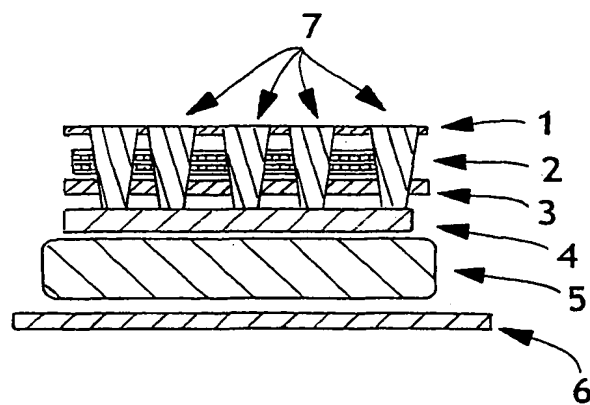


FIG. 6

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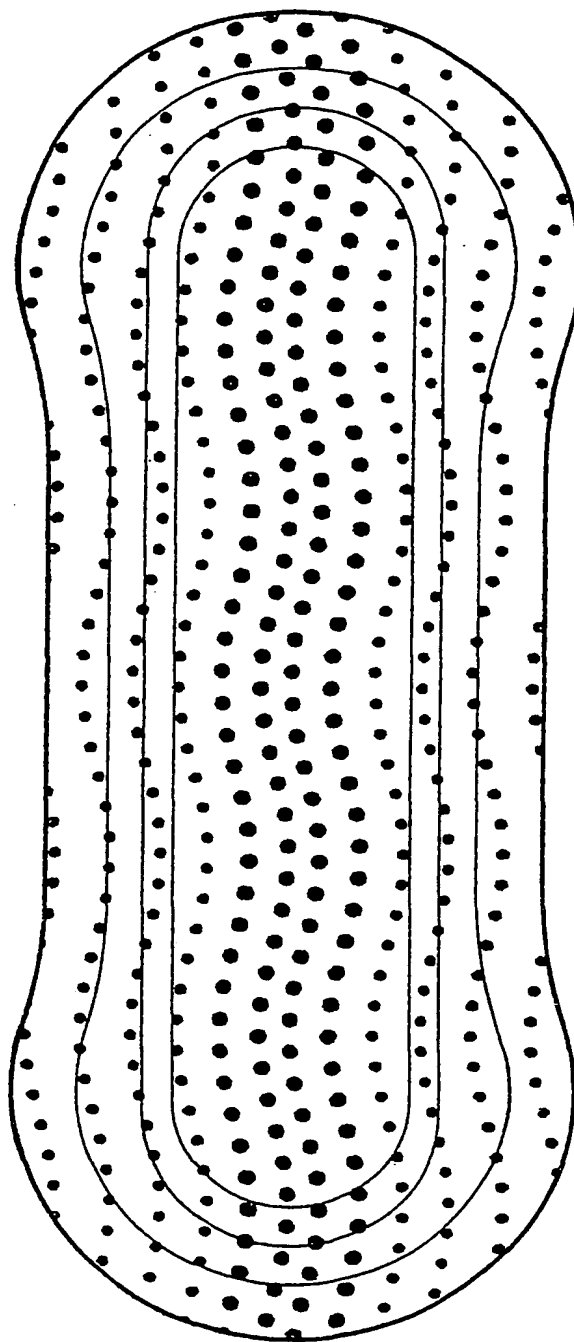


FIG. 7

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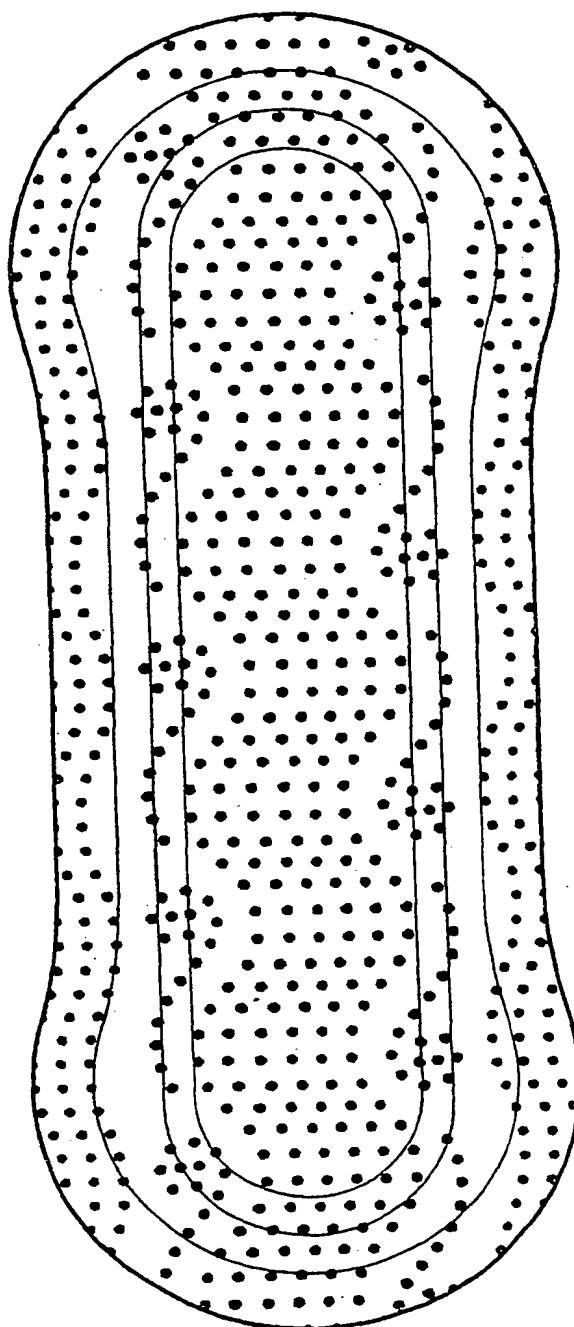


FIG. 8

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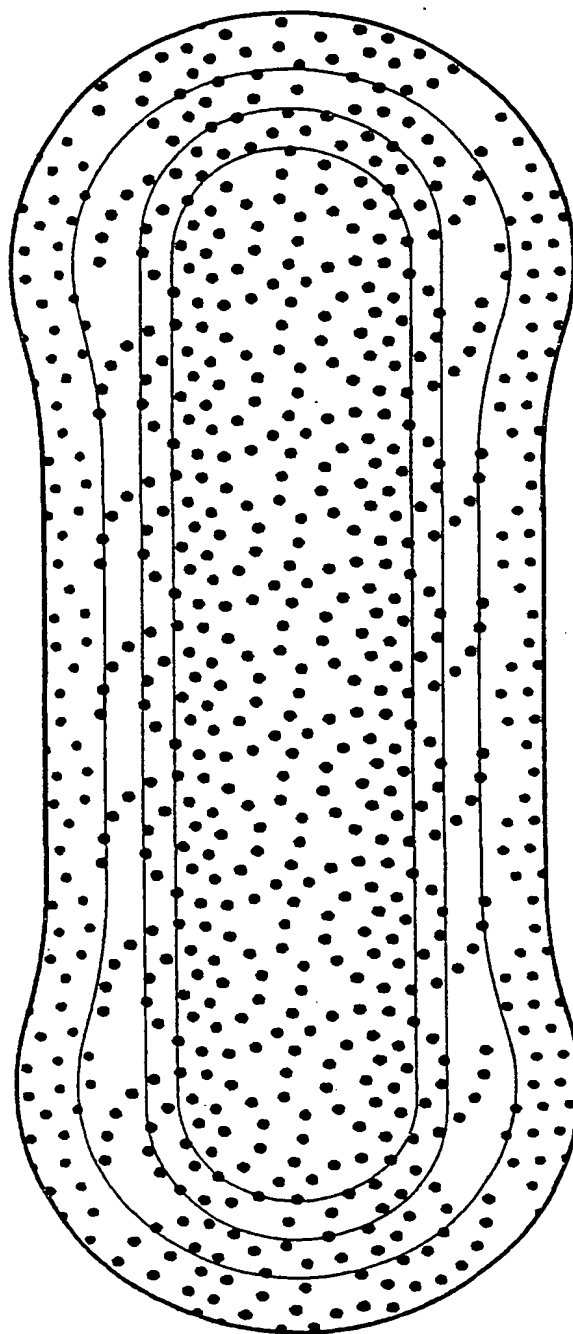


FIG. 9

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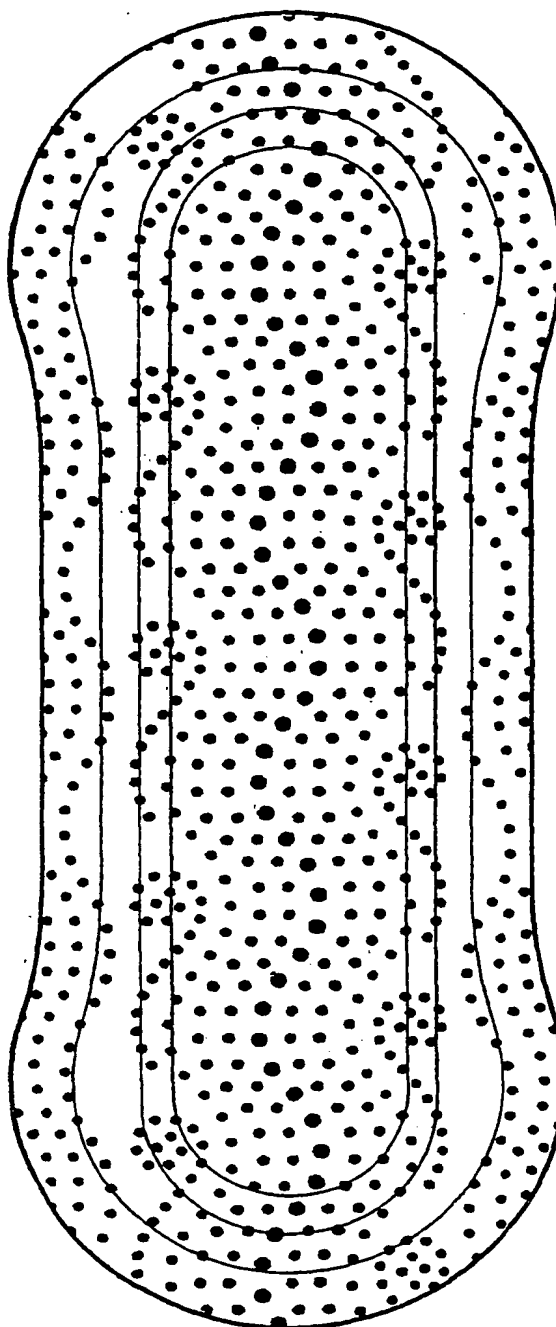


FIG. 10

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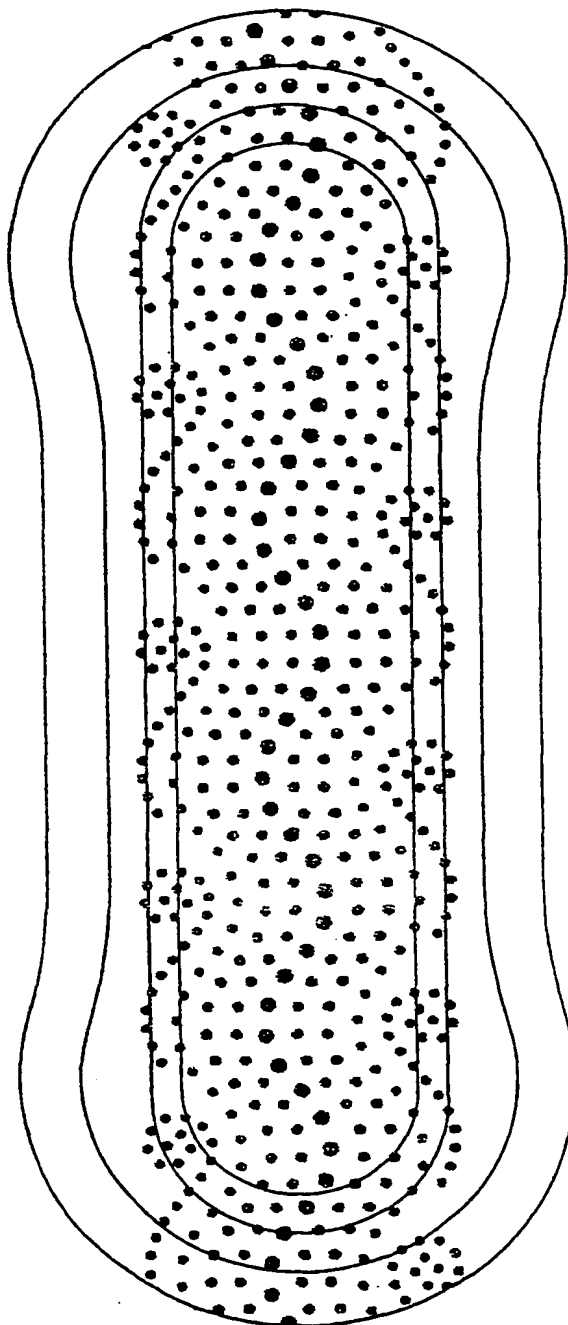


FIG. 11



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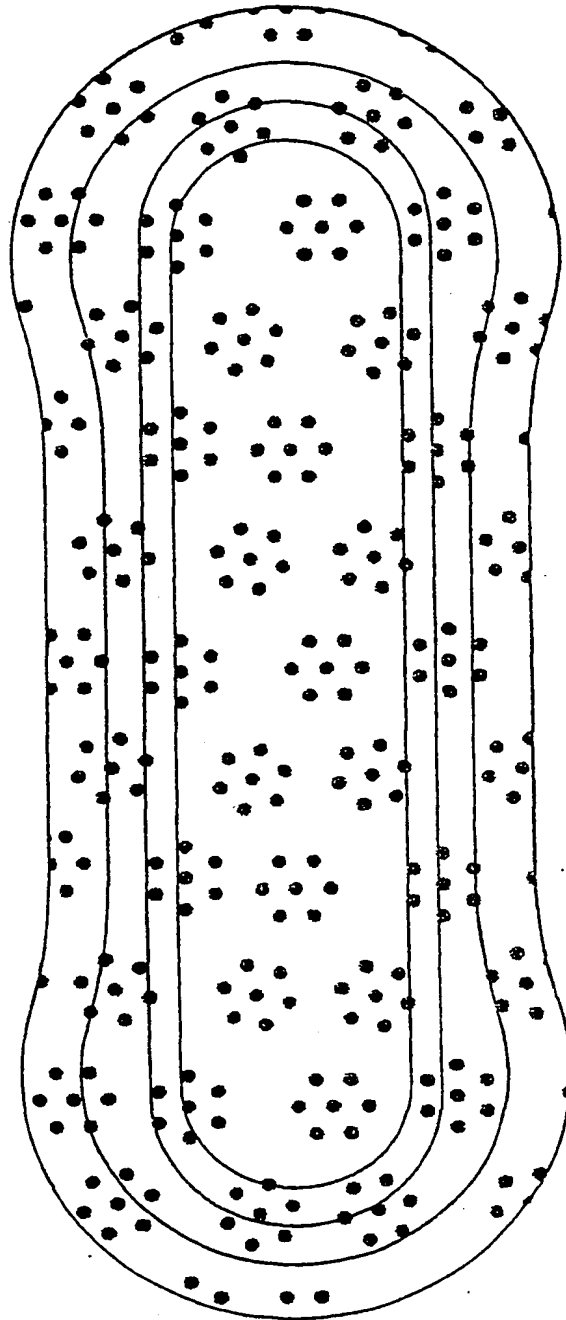


FIG. 12

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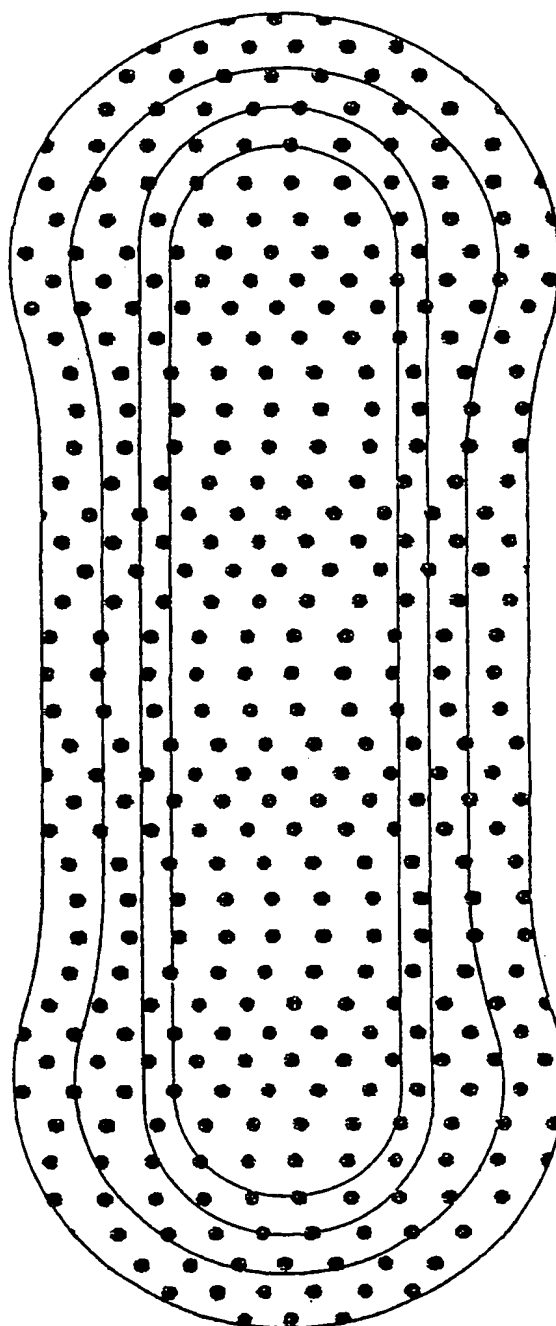


FIG. 13

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 01/09104

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A61F13/15 A61F13/537 A61F13/512

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X A	WO 99 25550 A (KIMBERLY CLARCK) 27 May 1999 (1999-05-27) page 5, line 1 -page 6, line 14 examples 1-6; tables 1-26	1, 3-5, 7, 9-11, 15 6, 16
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

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Date of the actual completion of the international search

12 September 2001

Date of mailing of the international search report

20/09/2001

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## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 01/09104

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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